



Ph.D. Dissertation Defense

Candidate:	Shengyu Huang
Degree:	Doctor of Philosophy
School/Department.:	School of Business / Financial Engineering
Date:	Tuesday, April 21, 2026
Time:	2:00 – 4:00 pm
Location:	Babbio 431
Title:	Implications of Machine Learning Model Complexity in Financial Systems
Chairperson:	Dr. Majeed Simaan, Finance/FE, School of Business
Committee Members:	Dr. Zachary Feinstein, Financial Engineering, School of Business Dr. Anand Goel, Finance, School of Business Dr. Foad Mahdavi Pajouh, Management, School of Business Dr. Yi Tang, Gabelli School of Business, Fordham University

Abstract

In asset pricing, a gap persists between traditional linear models and the increasing use of nonlinear machine learning (ML) methods. While nonlinear models often outperform their linear counterparts, the economic sources of the nonlinearities they capture remain largely unexplored. This dissertation, titled “Implications of Machine Learning Model Complexity in Financial System,” investigates the role of complexity in modeling asset returns and its broader implications for financial institutions and capital markets.

The first essay develops a theoretical framework to characterize when nonlinear modeling is essential. It shows that deviations from elliptical payoff distributions generate nonlinear pricing relationships, implying that firms with greater exposure to higher-order risks benefit more from nonlinear prediction models. Empirically, the advantage of nonlinear ML models is concentrated among stocks with high positive skewness, growth-oriented characteristics, and during periods of elevated market uncertainty.

The second essay introduces a novel, market-based measure of firm complexity that captures the difficulty investors face in mapping observable characteristics to stock returns. Using explainable artificial intelligence (XAI), the measure quantifies the nonlinearity of the prediction function and is applied to the banking sector. The results show that complexity is time-varying and state-dependent: it is associated with reduced trading activity and improved risk–return tradeoffs in normal periods, but increased vulnerability during market distress. In addition, higher complexity is linked to lower funding costs, suggesting important implications for bank structure and financial stability.

The third essay examines how firm complexity is priced in the cross-section of bank stock returns. Focusing on the bank size anomaly, it shows that while illiquidity explains a substantial portion of the anomaly, complexity provides additional explanatory power. In particular, the size anomaly largely disappears among highly complex banks, and complexity is positively associated with expected returns, especially for smaller institutions. These findings suggest that complexity is a distinct, priced factor in the cross-section of returns.